



ORIGINAL PAPERS

Results of treating distal radial fractures with a volar plate

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Received September 5, 2007; accepted January 3, 2008

KEYWORDS:

Radial fracture;
Wrist;
Volar plate

Abstract

Purpose: To assess the results of treating distal radial fractures with a volar plate. Other aims were to evaluate the concordance between functional scales and the Castaing radiological score and carry out a multivariate analysis of the preoperative data in order to find out which data were most relevant for the final result.

Materials and methods: A retrospective study was performed of 31 patients with a distal radial fracture treated with a volar plate. Patients were analyzed on the basis of age, side involved, fracture pattern according to the Fernandez' classification, and time-to-surgery. A functional evaluation was made using Gartland's scale as modified by Sarmiento, the modified Mayo Wrist Score, Castaing's functional scale and the DASH scale. In addition, a radiographic assessment was also carried out using Castaing's score and taking into account the occurrence of early and/ or late complications.

Results: All fractures went on to heal. Most patients obtained excellent or good functional results on the different functional scales used. Mean DASH score was 10.92. We cannot claim that the results have been influenced by the type of fracture sustained. There was one case of secondary displacement in an osteoporotic patient.

Conclusions: Treatment of distal radial fractures by means of a volar plate is a safe alternative that permits an anatomic and stable reduction as well as early wrist mobility. Good functional and radiological results can be obtained with few complications.

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PALABRAS CLAVE

Fractura de radio;
Muñeca;
Placa volar

Resultados del tratamiento de las fracturas de radio distal con placa volar**Resumen**

Objetivo: valorar el resultado de las fracturas de radio distal tratadas mediante placa volar. Como objetivos secundarios estaban comparar la concordancia entre escalas funcionales y la escala radiológica de Castaing y realizar un análisis multivariable de los datos preoperatorios para conocer cuáles eran relevantes en el resultado final.

Material y método: se realizó un estudio retrospectivo de 31 pacientes con fractura de radio distal tratada con placa volar. Se analizó a los pacientes en función de la edad, el lado afecto, el patrón de fractura según la clasificación de Fernández y la demora quirúrgica. Se realizó una evaluación funcional mediante la escala de Gartland modificada por Sarmiento, Mayo Wrist Score modificada, la escala funcional de Castaing y la escala DASH. También se realizó evaluación radiográfica con la escala de Castaing y se valoró si aparecieron o no complicaciones precoces y/o tardías.

Resultados: todas las fracturas consolidaron. La mayoría de los pacientes obtuvieron unos resultados funcionales excelentes o buenos en las distintas escalas de valoración funcional. La puntuación DASH promedio fue 10,92. No podemos afirmar que los resultados estén influidos por el tipo de fractura de los pacientes. Hubo un caso de desplazamiento secundario en una paciente osteoporótica.

Conclusiones: el tratamiento de las fracturas de radio distal mediante placa volar es una alternativa segura, que permite una reducción anatómica y estable, así como la movilización precoz de la muñeca, con buenos resultados funcionales y radiológicos con pocas complicaciones.

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Introduction

Distal radial fractures are some of the most prevalent fractures among the population. They account for 15% of upper limb fractures and occur mainly in white elderly patients¹. Ideal treatment of this type of fracture remains a controversial subject^{2,3}. There is consensus that anatomic reduction diminishes the occurrence of radiocarpal osteoarthritis⁴ and that the quality of the joint reduction is related with the final result^{5,6}. A joint step-off of less than 2 mm is acceptable.

Multiple studies have shown that open reduction and internal fixation can prevent sequelae derived from a poor reduction of the joint surface, such as pain, stiffness, joint instability and nerve compression.

Open reduction and internal fixation with plates is a good alternative for the treatment of displaced extra-articular and intra-articular fractures of the distal radius⁷⁻¹⁰. The advantages of plating include restoration of the bony anatomy, a stable internal fixation, a shorter immobilization period and a speedier recovery of wrist function⁷⁻¹³. These advantages cannot be obtained with external fixation or with percutaneous fixation with Kirschner wires and casting¹².

The purpose of the present article is to evaluate the functional and radiologic results of distal radius fractures treated with a volar plate.

Materials and methods

A transversal study was carried out of patients with a distal radius fracture operated in our hospital with a conventional

volar plate (Synthes 2.4), between January 2003 and December 2005. The inclusion criteria were as follows: skeletally mature patients with an unstable fresh (less than 4 weeks' old) distal radius fracture, treated with open reduction and a volar plate (according to the surgical technique described by Henry et al¹⁴), whose full clinical and radiological history was available. All radial fractures that extended beyond the distal third of the radial shaft were excluded, as were patients treated with other techniques (Kirschner wires, external fixator, dorsal plate or a combination of two or more treatments).

The 31 patients that met the inclusion criteria and agreed to participate in the study were reviewed by a single researcher. Data related to age, gender and occupation were gathered. Fracture-related data compiled were as follows: cause of the accident (fortuitous, sports-related, motor vehicle or occupational), affected side and concomitant lesions. Distal radius fractures were classified according to the criteria laid down by Fernández⁷. This classification was used to produce a description of the fracture anatomy and its connection with the mechanism of injury. The majority of fractures (64.5%) were operated within 24 hours of trauma.

Each of the patients was reviewed clinically and radiologically to analyze their outcomes. Four scales were used for the functional assessment of the injured wrist: Gartland's scale as modified by Sarmiento et al¹⁵, the modified Mayo Wrist Score¹⁶, Castaing's functional scale¹⁷ and the Spanish version of the DASH questionnaire^{18,19}. Gartland's scale as modified by Sarmiento assesses residual deformity, subjective classification, wrist function (by measuring the degrees of joint mobility with a goniometer) and the presence of complications; results were graded as

excellent (0-2 points), good (3-8), fair (9-20) and poor (>20). The Mayo Wrist Score evaluates wrist function on the basis of pain status, occupational situation, mobility and prehensile strength; results between 90 and 100 points were considered excellent; 80-89, good; 65-79, fair, and <65, poor. Castaing's functional scale compares the involved with the healthy side in terms of pain, mobility and prehensile strength; results between 8 and 9 points were considered very good, those between 6 and 7 good, those between 3 y 5 fair and those between 0 and 2 poor. The DASH questionnaire assigns scores between 0 and 100 points; the lower the score the lower the degree of functional limitation. The current radiograph of the injured wrist was used to apply Castaing's radiological scale¹⁷; which evaluates frontal inclination, sagittal inclination, the radio-ulnar joint line (these measurements are made with a goniometer) as well as the stage of radiocarpal arthritis, according to Knirk's scale⁴. Scores between 7 and 8 points were considered very good, 5-6 good, 3-4 fair and 0-2 poor.

The study also looked into the presence of post-surgical complications, such as complex regional pain syndrome, loss of reduction following surgery, infection, deep venous thrombosis of the operated limb, scapholunate dissociation, DeQuervain's disease and carpal tunnel syndrome. A record was made of whether these complications made it necessary to remove the osteosynthesis hardware. Preoperative variables studied were age, gender, occupation, mechanism of injury, affected side and time-to-surgery.

The statistical analysis carried out made it possible to determine the frequency and the percentage for the discrete variables and the mean and standard deviation for the continuous variables. The study of the differences between continuous variables was made as a function of the degree of compliance with the normalcy criteria (Kolmogorov-Smirnov test). The χ^2 test was used to compare the discrete variables. In order to evaluate potential variables related with the result ("excellent" score on the de Mayo Wrist Score), we conducted a multivariate logistic regression analysis. We chose this scale because it is the one that considers the largest amount of parameters when evaluating wrist function, which therefore makes it more demanding; the "excellent" score was chosen because every treatment is aimed at achieving such a score. We used the kappa index to assess the concordance of the results of the functional and radiologic scales. The SPSS 12 software was used to compute all the results.

Results

Of a total of 53 patients operated for a distal radius fracture by means of a volar plate (between January 2001 and December 2004), we obtained a total study population of 31 patients. Seven patients were excluded because of a lack of clinical or radiological data in their medical record and the remaining 15 because they refused to participate in the study when they were contacted by telephone. The sample was made up by 24 males and 7 females with a mean age of 40.5 ± 17.9 years.

On assessing the mechanism of injury, we observed that the injury had been sustained chiefly as a result of a fortuitous fall (low-energy trauma), especially in the elderly patients. On the other hand, fractures in the younger population were related to motor vehicle accidents (high-energy trauma). In terms of Fernández's classification⁷, 23% of fractures were type I, 26% type II, 28% type III and 23% type V; there were no type IV fractures.

All 31 fractures healed radiologically in a mean period of 7.5 ± 3.2 weeks. All fractures were immobilized postoperatively with a forearm splint for 1.8 ± 1.4 weeks. Fractures were followed up for 25.1 ± 21.9 months (range: 2-72). Wrist function assessment gave an acceptable mobility of the wrist joint, with wrist extension of $55.9^\circ \pm 15.3^\circ$, flexion of $60.4^\circ \pm 16.2^\circ$, radial deviation of $14.7^\circ \pm 9.2^\circ$, ulnar deviation of $33^\circ \pm 7.9^\circ$, pronation of $81.7^\circ \pm 2^\circ$ and supination of $80^\circ \pm 9.1^\circ$.

Functional results on Gartland's scale as modified by Sarmiento were: 20 (64.5%) patients with excellent results; 9 (29%), good and 2 (6.5%) fair. On the Mayo Wrist Score we obtained 18 (58.1%) excellent results, 11 (35.5%) good, 1 (3.2%) fair and 1 (3.2%) poor. On Castaing's scale we obtained 20 (64.5%) very good results, 9 (29%) good and 2 (6.5%) fair results; these results are in line with those obtained on Garland's scale. The DASH questionnaire produced an average score of 10.9 ± 13.3 .

An analysis of the anteroposterior and lateral radiographs of the 31 patients produced frontal inclination values of $24.2^\circ \pm 3.7^\circ$ and sagittal inclination to palmar of $2.4^\circ \pm 8.3^\circ$. The majority of patients (77.4%) showed a radio-ulnar distance of 0 to 2 mm, with a mean of 1.6 ± 0.6 mm. Castaing's radiological evaluation scale gave 19 (61%) very good results, 11 (35.5%) good and 1 (3.2%) fair result.

When comparing the concordance of functional results (as obtained with Castaing's and Gartland's scales) with the radiological results (Castaing's scale) with the kappa index, a concordance of 0.35 and 0.29 respectively was obtained, which indicates a weak association between functional and radiological results.

We carried out a logistic regression using the sequential exclusion mechanism, including the following variables: age, gender, affected side, fracture type, occupation, time-to-surgery, length of immobilization and follow-up period. Attainment of an "excellent" result on the Mayo Wrist Score was correlated, in a statistically significant way, with the patient's occupation and, marginally, with time-to-surgery. Both factors were negatively related with the result, so that for every day the surgery was delayed the likelihood of obtaining a good result went down by 20% (*odds ratio* [OR]=0.79; $p=0.051$); for self-employed workers the likelihood of obtaining an excellent result was 96% lower than for housewives (OR=0.046; $p=0.0059$). This result could have been influenced by a greater demand in the results of self-employed workers and by the fact that their mechanism of injury tends to be of higher energy than that of housewives. At any rate, the confidence interval of this value was extremely large, between 0.0053 and 0.4052, which may be related to the low number of patients in the category.

As regards complications, there were no cases of infection, deep venous thrombosis of the affected limb or

Table 1 Functional results at the end of follow-up (arithmetical mean)

	Extension	Flexion	Radial deviation	Ulnar deviation	Supination	Pronation
Own data	55.9°	60.4°	14.7°	33°	80°	81.7°
Orbay et al ²⁵ (2004)	58°	55°	13°	26°	76°	80°

scapholunate dissociation. Two cases (6.5%) of complex regional pain syndrome were observed in the first few months following surgery, which resolved with rehabilitative and pharmacological treatment. As regards the presence of radiocarpal arthritis, 6 cases (19.4%) of stage I arthritis on Knirk's⁴ classification were observed. Postoperatively, one patient presented with DeQuervain's disease, which resolved spontaneously; 3 (9.7%) patients presented with symptoms compatible with carpal tunnel syndrome that required surgical neurolysis. Hardware had to be removed in 4 patients because it caused discomfort.

Discussion

When addressing distal radius fractures, the main goal is to achieve an anatomic reduction and early mobilization, avoiding secondary displacement. Early mobilization of the wrist has shown itself to favor the functional recovery of the fingers and the hand⁴⁻⁶. To achieve these goals, surgeons have different surgical options at their disposal. The current trend is to achieve this goal by means of open reduction and internal fixation of the fracture. Among the advantages of plate fixation are the possibility to directly visualize the fracture, stability of the fixation, a shorter immobilization period and a speedier functional recovery, since a stable assembly provides for a fuller healing of the fracture and thereby a shorter period of wrist immobilization^{20,21}. A comparison of clinical and radiographic results has shown that a correct anatomic reduction is tantamount to a good functional result, although clinical-radiological concordance is not the rule²⁰.

Dorsal distal radius plates tend to lead to a high complications rate, with irritation, formation of adhesions and rupture of extensor tendons. Low profile plates have recently been developed to minimize the appearance of such complications. Use of external fixators in the wrist can only preserve reduction in certain fractures with large fragments²².

Volar plate osteosynthesis in the distal radius presents with a lower incidence of complications in the flexor tendons due to a larger space between the volar cortex and the tendon is larger and to the presence of the pronator muscle, which acts as a barrier^{14,21,22}. The volar cortex of the radius is not often as comminuted as the dorsal cortex and, furthermore, it has a large surface that allows a stable apposition of the plate.

Functional results are similar to those reported in the recent literature (table 1). Radiological results are better than those described by other authors as regards frontal inclination and poorer as regards sagittal inclination (table 2).

Table 2 Radiologic results at the end of follow-up (arithmetical mean)

	Frontal inclination	Sagittal inclination
Castellón General Hospital	24.22°	2.58°
Orbay et al ²⁵ (2004)	20°	5°
Orbay et al ²⁴ (2002)	21°	5°

In 33 patients with dorsally displaced distal radius fractures, Kamano²³ obtained, according to Gartland's scale, 12 excellent results, 20 good and one fair result, with no secondary fracture displacement. Orbay et al^{24,25}, in 31 patients, obtained 19 excellent and 12 good results, with no secondary displacement and with a mean DASH score of 8.28.

Significant differences regarding time-to-surgery have been found in the results ($p < 0.05$), so that patients operated earlier obtained better functional results.

The development of the new angle-stable distal radius plates can improve on the results obtained with LCP plates, especially in patients with poor bone quality. LCP plates have been in use in our hospital since 2005 and have become the standard plating system for these kinds of fractures. The results of these plates will be the subject of forthcoming studies.

To conclude, treatment of distal radius fractures with a volar plate is a safe alternative that provides a safe and anatomic reduction. It permits early mobilization of the wrist and achieves good functional and radiologic results with few complications. Excessive time-to-surgery and demanding occupational activities have been related to the failure to achieve excellent results. In this study, we found a low concordance level between the scores achieved on functional scales as compared with those on the radiological scale. Nor did we find differences between the results on the functional scales and the type of fracture classification, possibly owing to the size of the sample.

Conflict of interests

The authors have not received any financial support in the preparation of this article. Nor have they signed any agreement entitling them to receive benefits or fees from any commercial entity. Furthermore, no commercial entity has paid or will pay any sum to any foundation, educational institution or other non-profit-making organization to which they may be affiliated.

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